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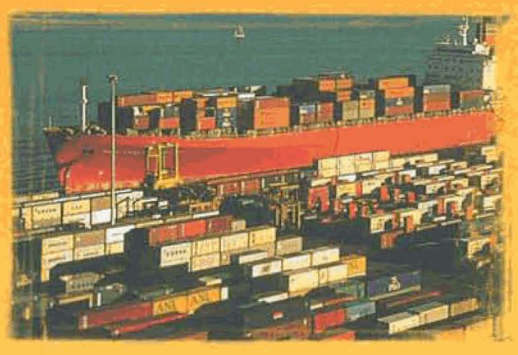

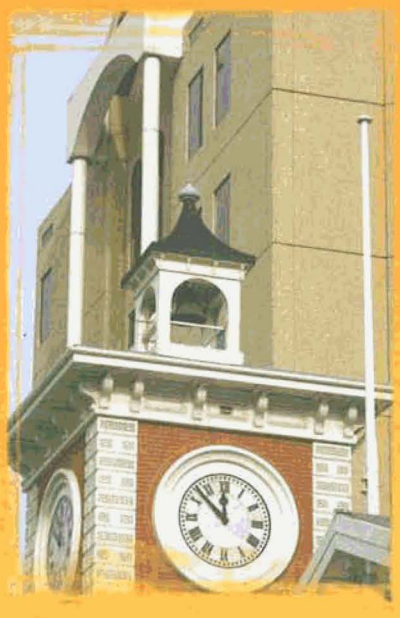

# Change in New Zealand Farmer and Grower Attitudes towards Gene Technology: Results from a Follow Up Survey


Andrew J. Cook
and
John R. Fairweather



Research Report No. 259
May 2003


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**Farm Surveys and Rural Monitoring**

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# Preface

This research report is part of a series assessing farmers' attitudes to gene technology. The particular focus of this report is the change in attitudes of those farmers who were surveyed in 2000 on their attitudes towards gene technology. Thus, the report compares the attitudes of 115 farmers resurveyed in 2002 with their responses in 2000. The research is important because there have been few studies, either in New Zealand or internationally, which have monitored farmer viewpoints so carefully. The results will be of use to farmers and policymakers interested in issues relating to organic farming and gene technology.

**Professor Caroline Saunders**
**Director**

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# Summary

This study examined changes in the intentions, attitudes and beliefs of farmers regarding their use of gene technology. Of 656 respondents to a postal survey in 2000, the views of 115 were assessed again in 2002. These follow up respondents indicated their intention to use gene technology, attitudes toward using gene technology and beliefs about market acceptance, commercial viability and environmental risk from using the technology. Results from this comparative study show how farmers' thinking about gene technology may have changed but they are not necessarily a good indication of New Zealand farmers and growers views in 2002 (this topic is covered in AERU Report No.258).

After two years, attitudes and intentions to use gene technology had undergone a minor, non-significant, change towards more positive intentions to use the technology. However, some significant shifts had occurred. These farmers and growers were found to be less supportive of New Zealand becoming GE free. In addition, they thought it less likely that gene technology would cause damage to ecological systems and endanger public health. It was also thought more likely that economic growth would occur from using gene technology, and that using gene technology would increase food production.

Overall only a minor change in farmer response was found to have occurred over the two-year period between measurements. Nevertheless, results showed a link between the consequences of using gene technology and farmer and grower attitudes and intentions. Consequently, prospects for change in attitudes and beliefs about the consequences of using gene technology are discussed as key determining factors in farmer and grower decisions regarding their use of gene technology.

# Chapter 1
# Introduction: General Background, Research Objectives and Design Rationale

## 1.1 Background

A survey of New Zealanders conducted by the Royal Commission on Genetic Modification, (2001) (N = 1,153) found a good deal of public disapproval for use of gene technology in processed foods (73 per cent) farm animals (70 per cent) and crops (58 per cent). This finding is, however, not surprising given that national public surveys have revealed more concern than approval over the use of gene technology in food production (Couchman and Fink-Jensen, 1990; Macer, 1994; Macer, 1998; Gamble et al., 2000). These surveys have found the public has ethical, environmental and public health concerns relating to genetic engineering.

More recently there has been an increase in media reports on genetic engineering associated with, among other issues, Government moves to regulate the sale and production of GM food. It is possible that public awareness of these issues has been raised, and, following the Government's lead, the public may be more accepting of gene technology. These possible changes in public attitude may be mirrored in farmer attitude. Rather than leaving farmer attitude to be a matter for conjecture, this study took the simple step of asking farmers and growers that were surveyed in 2000 to again report their views on gene technology. The original AERU survey, conducted by Cook, Fairweather and Campbell (2000), recorded the views of farmers and growers, assumed to be a key group in the introduction of gene technology to agriculture Their views were encapsulated by asking about their intentions to make use of gene technology. Analysis of the data found that market acceptance, commercial viability and environmental risk were important criteria in farmer and grower decisions about using gene technology.

## 1.2 Aims and objectives

The aim of this study was to investigate changes in the intentions of farmers and growers regarding the use of gene technology in agricultural production through a repeat in 2002 of a survey used in 2000. The 2000 study extended earlier analytical work (reported by Cook, Kerr and Moore, 2002) and sought to explain and predict the dynamics of farmer and grower decisions. A claim of the 2000 study was that intentions to use gene technology were linked to attitudes and beliefs about the technology. In re-testing these key factors, a change in intention accompanied by a requisite change in attitude and beliefs would support that claim.

## 1.3 Design rationale

Although samples of the various populations have been undertaken at different times, it is evident that no New Zealand study has re-surveyed individuals about their attitudes towards applications of gene technology. As a time series study, re-surveying individuals rather than re-sampling a population has a methodological advantage in that it avoids the issue of sample bias. In this study the changes in responses are clearly the result of changes in the opinion of

the individual, rather than being the result of artefacts from differences between population samples.

In addition to presenting results of the re-survey, selected results from a 2002 comprehensive study of farmers and growers (N = 805; Fairweather, Maslin, Gossman & Campbell, 2003) are also presented and compared to both the results from the 2000 study and the re-survey results. Included in the independent 2002 study were three questions for comparison with results from the 2000 study. The 2000 results and the independently measured 2002 results are compared to further assist in assessing changes in farmers and growers thinking about gene technology.

# Chapter 2
# Literature on Attitudes towards Gene Technology

## 2.1 Introduction

The purpose of the following literature review is to provide some familiarity with the now modest and growing amount of research overseas and in New Zealand relating to attitudes towards gene technology and related issues.

Before proceeding to the New Zealand literature we give an overview of the international literature. Internationally, a variety of research techniques have been employed to study public opinion or attitudes towards GM food. A number of reviews of overseas studies have been undertaken (e.g., Zechendorf, 1994; Hamstra, 1998; Norton, 1998; Bredahl, Grunert, & Frewer, 1998; Campbell et al., 2000). As indicated in the review by Campbell et al. (2000) internationally two authors are noteworthy as having dominated published research in the topic area. Hoban (e.g. 1996; 1996a; 1998) has been predominant in conducting opinion poll type surveys of principally North American views on GM food issues. Frewer and associates (e.g., Frewer, Howard, & Shepherd, 1996; Frewer et al. 1998; Frewer et al., 1999) of the London Food Research Institute have been prolific in the applying a range of analytical techniques to the topic area. For example, Frewer et al. (1998) discussed the merits of cognitive mapping within a risk perception approach and Frewer, Howard, and Shepherd, (1996) investigated the utilisation of a choice modelling technique. Among this international literature there have been few re-surveys.

## 2.2 New Zealand Studies of Attitudes towards Gene Technology

There have been many studies of public reactions to the use of genetic engineering in New Zealand. The following review updates the earlier review provided in Cook, Fairweather and Campbell (2000), Over the past twelve years there have been several studies conducted in New Zealand that have sought to gauge the acceptability of genetic engineering. The first, undertaken by means of face-to-face interviews, examined the attitudes of 2,034 adults to the genetic manipulation of a number of different organisms (Couchman & Fink-Jensen, 1990). The survey found that 74 per cent of respondents were aware of genetic engineering as a technology, of which 57 per cent thought research in this area was beneficial. The acceptability of the genetic engineering of plants (85.5 per cent) and animals (56.6 per cent) was higher than that of manipulating human cells (42.5 per cent). The majority of those surveyed (75 per cent) were aware that genetically modified organisms could be used to produce food and medicines, and 50 per cent were concerned about eating GM food.

A mail survey was conducted by Macer (1994), which drew a sample of 329. The survey found that 56 per cent of respondents indicated that genetic engineering of plants was acceptable and that 29 per cent considered the genetic engineering of animals to be acceptable. The 80 per cent of respondents who were aware of the use of the technology to produce food were asked their level of concern in relation to types of food products. Genetic manipulation of meat was of most concern, followed by dairy products and then vegetables. Respondents also reported the reasons for their level of concern. The most common reason against genetic modification was that the foods were considered to be unnatural (20 per cent) and 11 per cent reported the concern that safety measures were inadequate.

A further relevant study was conducted by means of telephone interviews that focused on gauging public opinion of the use of genetic engineering as a method of biological control (Fitzgerald, Saunders & Wilkinson, 1996). Of the 1,017 respondents, 89.5 per cent expressed familiarity with the potential of the technology to increase the quality or quantity of agricultural products. In a measure of the acceptability of the use of genetic engineering in agriculture 14 per cent found it unacceptable, 18 per cent reported indifference and 65 per cent reported approval.

Richardson-Harman, Phelps, Mooney and Ball (1998) report on a 1996 study (N = 511) of attitudes to the use of genetic engineering in fruit production. When asked if they would knowingly eat an apple that had been genetically engineered 62 per cent indicated they would if it was of increased size, 67 per cent would if it had improved flavour and 66 per cent indicated they would given reduced chemical residues.

A more recent survey, conducted as part of an international study, was undertaken by means of a telephone survey (Macer, 1998). Of the 508 respondents, 69 per cent expressed approval for the use of genetic engineering in the production of food and drinks. The respondents were also found to have a relatively better understanding of genetic engineering than people in most other countries including Japan, Canada and the European Union. Sixty-six percent of respondents considered that the genetic engineering of crop plants for resistance to pests should be encouraged.

Research by Sharland (1999) focused on determining reactions to labelled GM food. The research used choice modelling to compare shopper reactions to non-GM food and food labelled as GM with a variety of price differences. The research found that choice was generally unrelated to knowledge of the technology and, while price influenced choice, more expensive non-GM food was generally favoured over GM food. The study also concluded that the comparative utility of a number of respondents did not alter for GM food regardless of price, nutritional value or taste.

Research comprising four separate studies was undertaken by Gamble et al. (2000). In the first study, 36 people participated in focus group discussions of GM food. The study found that food safety and risk to the environment were associated with GM food. GM food was also associated with food that had been produced using pesticides or food that had been irradiated. In addition, respondents reported that while they were aware of the technology, they had little understanding of genetic engineering. The second study engaged 60 growers from regions of the North Island in focus group discussions. A third of the growers were willing to utilise the technology and it was noted that only a small shift in attitudes would increase this proportion. Growers would, however, be less responsive should their action result in no benefits to themselves. The third study employed conjoint analysis to interpret responses of 115 participants. The participants in interviews reported whether or not they would purchase chocolate biscuits or tomatoes that were presented to them. Purchase of the products was considered using various descriptions including their being genetically modified. The exercise was followed by the completion of a questionnaire by the participants. The study found that price was important in the purchase decisions and was more important than health or environmental concerns. A proportion of the participants were described as ‘neophobic’; that is, as being reluctant to accept the technology. A postal survey was undertaken for the fourth study, which received 809 responses. The respondents were asked to consider purchasing either a GM tomato or a pair of jeans made from GM cotton. The study utilised a variation of the Theory of Planned Behaviour (TPB). Attitudes towards the use of

genetic engineering in food production were predominantly negative. Most respondents indicated they would avoid purchasing the two products.

Cook, Kerr and Moore (2002) extending upon Cook (2000), also utilised the TPB and modelled intentions to purchasing GM food. Three focus groups (N = 26) were utilised for questionnaire development. One focus group consisted of residents of a farming community. Discussions centred on beliefs about the outcomes of using the technology in food production, including risks to the environment, harm to public health and improvements in food quality. Of 266 respondents to the postal survey, 60 per cent intended not to purchase, ten per cent intended to purchase and 10 per cent had no intention to either purchase or not purchase. In keeping with the TPB, beliefs about the outcomes of purchasing, sense of self-identity, personal control over purchasing and the views of family and friends were identified as proximal determinants of intentions to purchase. Relationships were also identified between model components and belief in statements by companies, prior purchasing behaviour, gender, and age.

An AERU study undertaken by Cook, Fairweather and Campbell (2000) extended upon Cook (2000) to design a TPB study of farmer and grower intentions regarding purchase of GM food and use of genetic engineering technology. The survey of New Zealand farmers and growers (N = 656) found that 49 per cent intended not to purchase, 12 per cent intended to purchase and 39 per cent had no intention to either purchase or not purchase. Twenty one per cent intended to use the technology on their farm or orchard within the next ten years and 44 per cent had negative intentions. For intentions to purchase and intentions to use the technology, the three model elements of attitude, Subjective Norm and Perceived Behavioural Control were found to be significant determinant variables. The study also tested for and found evidence of relationships with 15 external components, though nine of these related to farming practices.

A further AERU study by Fairweather, Campbell, Tomlinson and Cook (2001) provided supplementary analysis of the data from the Cook, Fairweather and Campbell (2000) study. This second analysis further interrogated the data by means of the categorisation of organic, conventional and GE intending farmers. The results discriminated between the farmer categories based on a variety of factors including beliefs about nature, environmental values, reports of actual farming practices and the consequences of each practice.

A study undertaken for the Royal Commission on Genetic Modification (2001) surveyed 1,153 New Zealanders by telephone. The study focussed primarily on the importance of the technology for New Zealand's future. Few respondents (7 per cent) considered themselves well informed. Many respondents considered there were disadvantages in using genetic modification in processed foods (69 per cent), farm animals (59 per cent) and crops (49 per cent). In addition, disapproval was indicated by respondents for use of the technology in processed foods (73 per cent) farm animals (70 per cent) and crops (58 per cent).

Gamble and Gunson (2002) report on a national telephone survey (N = 800). Four hundred respondents were surveyed in May 2001 and 400 respondents were surveyed in October 2001. The surveys were undertaken prior to and after the Royal Commission on Genetic Modification. The study revealed less averse reactions to products with consumer benefits and there was more aversion to GM meat than other food types. In addition, more people surveyed in the second part of the study reported checking food labels than in the first group that had been surveyed.

The most recent AERU study (Fairweather, Maslin, Gossman & Campbell, 2003; N = 805) clarified further farmer and grower views about genetic engineering. The study measured levels of support for different uses of genetic engineering and their responses to issues associated with genetic engineering. By defining organic, conventional and GE intending farmers and growers, the measurement of environment attitudes, opinions about farming sustainability and worldviews contributed to a broad-based understanding of current views and future trends in New Zealand agriculture.

## 2.3 Conclusion

This brief review shows that there have been a number of studies into attitudes to genetic modification. However, among the New Zealand research there have been no studies that have resurveyed respondents in order to assess change in their opinions. The research closest to such a resurvey was Gamble and Gunson (2002) who surveyed public opinion before and after the Royal Commission.

The lack of resurvey research is understandable since, from a methodological point of view, if the research objective is to gauge change in opinion over time two separate random samples should be used to ensure that at each point in time the population is adequately represented. A design using two samples is more likely to be needed than resurveying the original sample and this is reflected in the literature, Notwithstanding this methodological consideration, a resurvey design has some advantages and these will be noted in the next chapter.

# Chapter 3
# Method: Key Results of the 2000 Study and Design of the 2002 Resurvey

## 3.1 Introduction: The 2000 Study

In 2000, Cook, Fairweather and Campbell (2000) found that, given the availability of gene technology in the following ten years, 21 per cent of New Zealand farmers and growers intended to make use of gene technology. Of the remainder, 44 per cent intended not to use of the technology and 35 per cent were undecided. These intentions were found to be strongly linked (r = .73) to attitudes towards using the technology. Forty-four per-cent of farmers and growers had a favourable attitude, 48 per cent were unfavourable and 18 per cent were neither favourable nor unfavourable. Also in correspondence with farmer and grower intentions (r = 0.64), when asked whether they agreed or disagreed that 'New Zealand should try and achieve GE free status' most agreed (49 per cent) some disagreed (32 per cent) and 19 per cent neither agreed nor disagreed.

The 2000 study also found that consequences of using gene technology were important in farmer and grower decisions. The following eight consequences were generally assessed by farmers and growers in accordance with their attitudes towards using gene technology (r = 0.62).

- Better quality food
- New risks to public health
- Enhanced economic growth for New Zealand
- Consumer acceptance of foods produced using gene technology
- Adverse effects on future generations
- Damage to ecological systems
- Increased food production
- Personal risk

The study utilised an adaptation of the Theory of Planned Behaviour (TPB; Ajzen, 1991) to assist in structuring and understanding farmer and grower decisions. This popular model from Social Psychology has received substantial empirical support (Armitage and Conner, 2001). Following the central axioms of the TPB, the study of farmers and growers modelled the relationship between beliefs, attitudes and intentions as key factors in the decisions of farmers and growers. Central to the TPB is the hypothesis that beliefs about the consequences of performing a behaviour are the principle reasons for an attitude and subsequently an intention to perform a behaviour. Consequently, beliefs are assumed to be a prominent factor in personal decisions as revealed by a relationship with an attitude that is correspondent with intention. Based upon this sequence, Cook, Fairweather and Campbell (2000) extended upon the findings to predict that changes in the decisions of farmers and grower hinged upon their beliefs about the consequences of utilising gene technology in their production processes.

### 3.2 The Re-survey in 2002

The re-survey questionnaire was designed to gather responses in 2002 to selected key questions from the 2000 study with respect to their importance as factors in farmer and grower decision making. Since it used only these questions the questionnaire was consequently shorter than the 2000 questionnaire, although its format and question style was unchanged. The survey was conducted in September and October 2002, approximately two years after the 2000 survey, which was conducted from May to August 2000. Two hundred questionnaires were posted to farmers and growers randomly selected from the 656 respondents to the 2000 study. The short questionnaire contained 12 questions presented in the form of an A4 booklet. A freepost envelope was included for return of the questionnaire. Rather than showing the questionnaire in an appendix, the following paragraphs explain the questions and the response scales that measured the items presented here.

Intention to use gene technology was measured by asking: *Which one of the following statements best represents your intention to either use or not use gene technology on your farm within the next ten years?* Respondents could answer by choosing one of a range of seven statements anchored by: *I have a very strong intention to use gene technology* and *I have a very strong intention not to use gene technology*. The mid-point of the scale was anchored by: *I have no intention to either use gene technology or not to use gene technology.* Intention to purchase GM food and intention to use organic methods was similarly measured using the respective referents of *purchase GM good* and *use organic methods.*

Three attitude measures were assessed by asking: *How favourable or unfavourable is your general attitude towards the following three items?* Attitude to *using gene technology, purchasing GM food* and *using organic methods* were then each measured on seven-point scales anchored by *extremely unfavourable* and *extremely favourable*.

The eight beliefs about the outcomes of using gene technology from the 2000 study (presented in Section 3.1) were assessed. Each belief was measured using two questions, one question assessed the importance of the consequence and one question assessed the likelihood of its occurrence. Likelihood was measured on a seven-point scale anchored by *extremely unlikely* and *extremely likely*. 'Importance' was measured on a seven-point scale of desirability anchored by *extremely undesirable* and *extremely desirable.* Assessing both likelihood and desirability of the consequences of using gene technology meant that there were sixteen questions about consequences of the use of gene technology.

To explain how these questions are incorporated in farmers and grower's decisions, following Ajzen (1991) it is presumed that in forming an intention individuals summarise a number of important beliefs. This summation is modelled by first multiplying together the likelihood and desirability scores for each of the eight beliefs. The products are then summed. This produces a single measure of beliefs, which is presumed to be a basis of an individual's attitude towards a behaviour, which in this case is using gene technology.

Measurement was also taken of the level of agreement or disagreement with New Zealand becoming GE free. These measurements were taken seven-point scales anchored by *very strongly agree* and *very strongly disagree*.

Additional questions from the 2000 survey were used to record demographic information and farm characteristics.

### 3.3 Representativeness

The re-survey received an effective response rate of 63 per cent (N = 115). Comparison of the 115 respondents with the 200 that were invited to complete the re-survey was conducted to investigate the possibility of response bias. With regard to information derived from the original survey conducted in 2000, no significant differences were found (Chi sq., $p > 0.05$). The information utilised and results of these tests are provided in Table 1.

**Table 1**
**Comparison Between the Sub-sample and the Original Sample**

| | Chi square | Degrees of Freedom | Significance |
|---|---|---|---|
| **Farm type** | 1.74 | 4 | 0.78 |
| **Sex** | 0.24 | 1 | 0.62 |
| **Age** | 1.37 | 5 | 0.93 |
| **Gross Income** | 8.40 | 5 | 0.14 |
| **Farm size** | 0.62 | 5 | 0.99 |
| **Qualification** | 5.67 | 7 | 0.58 |

To test whether the sub-sample was representative of the population of farmers and growers comparison was made between farm type for the 115 respondents and the farmer and grower population. No significant difference (Chi sq 1.68, df 4, $p > 0.05$) was found between farm type and national classifications of farm type supplied by Quotable Value New Zealand. Quotable Value New Zealand had supplied the original random sample from a comprehensive list of 106,880 holdings along with the classifications of farm type. Comparing the sub-sample with the population from which the survey sample was drawn indicated the sub-sample was representative of the population. We note, however, that while the sample represents the population in 2000 it may not represent the population in 2002 since the population itself may have changed in some ways in the interim. Further, it is a small sample and this limits its utility in representing the farm population.

### 3.4 Conclusion

The design for the re-survey worked well in practice with a higher than average response rate from the re-surveyed farmers and growers. This is perhaps not surprising since the they had responded to the invitation to participate in the first survey in 2000 and were probably favourably disposed to reply again, The resulting sample is similar to the original sample and therefore can indicate change in attitude among the resurveyed farmers and growers.

# Chapter 4
# Results

## 4.1 Introduction

This chapter presents the results from the re-survey. Descriptive results are first presented for measurements taken in both 2000 and 2002 and test results for significant differences are also provided. Changes between measures are further gauged by correlation between measures taken in both 2000 and 2002. A cross-tabulation between intention measured in 2000 and 2002 is then presented to investigate further changes in farmer and grower intentions to use gene technology. Relationships between items are then examined to investigate linkages between the beliefs of farmers and growers and their attitudes and intention to use, or not use, the technology. A summary of results from the comparison between intentions and attitude measurements from the independent 2002 study is then provided.

## 4.2 Descriptive results

Descriptive results are provided in Table 2. In terms of differences between 2000 and 2002, except for level of agreement with New Zealand becoming GE free, (paired sample t-test, $p < 0.001$), there was no evidence of significant differences (paired sample t-test, $p > 0.05$) between 2000 and 2002. The results suggest that attitudes and intentions had become slightly more favourable towards using gene technology and purchasing GM food. Intentions and attitudes towards using organic methods were slightly less positive in 2002. These minor changes were, however, non-significant. In contrast, it is evident there was less agreement with the view that New Zealand should become GE free.

Both the 2000 and 2002 results show that intention to use gene technology and purchase GM food was generally negative, while intention to use organic methods was generally positive. Intention to purchase GM food was more negative than intention to use gene technology. Examination of frequency of responses from 2002 shows that 41 per cent had a negative intention towards using gene technology, 34 per cent had no intention to either use or not use the technology and 25 per cent had a positive intention to use the technology. In terms of intentions to purchase GM food, 43 per cent had a negative intention towards purchasing GM food, 40 per cent had no intention to either purchase or not purchase and 17 per cent had a positive intention to purchase GM food. Positive intentions (38 per cent) were more predominant for the use of organic methods with 47 per cent having no intention to either use or not use organic methods and 14 per cent having a negative intention. Examination of frequency of responses for agreement or disagreement that New Zealand should become GE free showed that 50 per cent disagreed, 17 per cent neither agreed nor disagreed and 33 per cent agreed. In 2000 the proportion was 39 per cent disagreed, 13 per cent neither agreed nor disagreed and 48 per cent agreed for the 115 respondents.

**Table 2**
**Intentions and Attitudes, 2000 and 2002**

| | | 2000 | 2002 |
|---|---|---|---|
| **Intention to use gene technology** | Mean | -0.61 | -0.56 |
| | Std dev | 1.43 | 1.63 |
| | n | 113 | 112 |
| **Intention to purchase GM food** | Mean | -0.74 | -0.67 |
| | Std dev | 1.43 | 1.53 |
| | n | 115 | 112 |
| **Intention to use organic methods** | Mean | 0.43 | 0.40 |
| | Std dev | 1.20 | 1.23 |
| | n | 115 | 112 |
| **Attitude towards using gene technology** | Mean | -0.53 | -0.31 |
| | Std dev | 1.93 | 1.85 |
| | n | 114 | 108 |
| **Attitude towards purchasing GM food** | Mean | -1.00 | -0.82 |
| | Std dev | 1.60 | 1.64 |
| | n | 112 | 107 |
| **Attitude towards using organic methods** | Mean | 0.62 | 0.59 |
| | Std dev | 1.57 | 1.64 |
| | n | 114 | 109 |
| **Try to achieve GE free status** | Mean | 0.45 | 0.14* |
| | Std dev | 1.94 | 1.89 |
| | n | 108 | 108 |

Note: 1. Range = -3 to 3 for all items.
2. *Paired sample t-test found a significant difference ($p < 0.001$).

Table 3 shows the descriptive results for desirability and likelihood of consequences of using gene technology. Similar mean scores to 2000 were found for 2002. In general, positive consequences were judged marginally more likely and more desirable in 2002 and similarly, negative consequences were judged either less likely or less undesirable. In 2002 desirable consequences including better quality food, enhanced economic growth and increased food production and negative consequences were generally judged likely. However, only five of the changes in desirability and likelihood of consequences were significant (paired sample t-test, $p < 0.05$). These changes were for desirability and likelihood of increased food production and likelihood of new risks to public health, enhanced economic growth and damage to ecological systems. In 2002, consumer acceptance was judged unlikely and adverse consequences, except for personal risk, were judged likely. Adverse effects were logically rated very undesirable, whereas better quality food, economic growth, consumer acceptance and increased food production judged in general as desirable. Increased food production was judged the most desirable outcome from using gene technology and of the eight consequences was generally considered the most likely consequence.

**Table 3**
**Likelihood and Desirability for Eight Consequences of Gene Technology, 2000 and 2002**

| | | Desirability | | Likelihood | |
|---|---|---|---|---|---|
| | | **2000** | **2002** | **2000** | **2002** |
| **Better quality food** | Mean | 0.57 | 0.77 | 0.09 | 0.11 |
| | Std dev | 1.71 | 1.65 | 1.9 | 1.65 |
| | n | 108 | 110 | 112 | 110 |
| **New risks to public health** | Mean | -1.71 | -1.78 | 0.51 | -0.78* |
| | Std dev | 1.45 | 1.35 | 1.77 | 1.35 |
| | n | 108 | 112 | 112 | 110 |
| **Enhanced economic growth** | Mean | 0.82 | 1.03 | -0.02 | 0.46* |
| | Std dev | 1.58 | 1.51 | 1.62 | 1.66 |
| | n | 108 | 109 | 111 | 114 |
| **Consumer acceptance** | Mean | -0.04 | 0.12 | -0.48 | -0.26 |
| | Std dev | 1.73 | 1.64 | 1.46 | 1.4 |
| | n | 107 | 109 | 111 | 114 |
| **Adverse effects for future generations** | Mean | -1.70 | -1.97 | 0.38 | 0.09 |
| | Std dev | 1.52 | 1.23 | 1.71 | 1.77 |
| | n | 107 | 111 | 112 | 113 |
| **Damage to ecological systems** | Mean | -1.79 | -2.07 | 0.62 | 0.14* |
| | Std dev | 1.42 | 1.18 | 1.69 | 1.83 |
| | n | 106 | 111 | 113 | 114 |
| **Increased food production** | Mean | 0.54 | 0.96* | 1.16 | 1.22* |
| | Std dev | 1.57 | 1.5 | 1.41 | 1.25 |
| | n | 107 | 111 | 112 | 114 |
| **Personal risk** | Mean | -1.83 | -2.00 | 0.11 | -0.17 |
| | Std dev | 1.56 | 1.2 | 1.82 | 1.73 |
| | n | 107 | 111 | 112 | 114 |

Note: 1. Desirability and likelihood range = -3 to 3.
2. * Paired sample t-tests found significant differences ($p < 0.05$).

### 4.3 Assessing Change Based on Correlations

To investigate further the changes in farmer and grower responses between 2000 and 2002, correlation between responses to the survey questions for each year are provided in Table 4 and Table 5. The paired sample t-tests results provided with the descriptive results (Table 2 and Table 3) indicated a meaningful change had occurred in responses to five of the fifteen questions. The correlation results provide a different view and can be interpreted as showing consistency, or inconsistency, in responses between 2000 and 2002.

To interpret the correlation results, an r-value of zero would indicate absolute inconsistency between 2000 and 2002 whereas an r-value of one would indicate absolute consistency or no change at all between 2000 and 2002. To judge degrees of consistency an r-value above 0.5 is taken to be consistent, an r-value between 0.3 and 0.5 is interpreted as indicating moderately consistent and an r-value below 0.3 is interpreted as inconsistent.

The correlation results in Table 4 show the responses can be judged as consistent or moderately consistent. Similar levels of consistency were found for most of the correlation results in Table 5. Four of the correlation measures can be judged as inconsistent or as having changed to a significant degree over the two-year period between the surveys. However, because of the characteristics of the distribution of scores for three of the items, inconsistency or a large change in responses, can only be attributed to views regarding the prospect of 'new risks to public health' from the use of genetic engineering.

**Table 4**
**Correlation Results for Intentions and Attitudes, 2000 and 2002**

| | n | r |
|---|---|---|
| **Intention to use gene technology** | 108 | 0.59 |
| **Intention to purchase GM food** | 110 | 0.53 |
| **Intention to use organic methods** | 109 | 0.31 |
| **Attitude towards using gene technology** | 107 | 0.45 |
| **Attitude towards purchasing GM food** | 106 | 0.47 |
| **Attitude towards using organic methods** | 107 | 0.32 |
| **Try to achieve GE free status** | 108 | 0.50 |

**Table 5**
**Correlation Results for Consequences, 2000 and 2002**

| | Desirability | | Likelihood | |
|---|---|---|---|---|
| | n | r | n | r |
| **Better quality food** | 104 | .46 | 111 | .57 |
| **New risks to public health** | 106 | .20 | 111 | .49 |
| **Enhanced economic growth** | 103 | .63 | 110 | .59 |
| **Consumer acceptance** | 102 | .43 | 110 | .36 |
| **Adverse effects for future generations** | 102 | .12* | 111 | .52 |
| **Damage to ecological systems** | 103 | .05* | 112 | .43 |
| **Increased food production** | 104 | .41 | 111 | .43 |
| **Personal risk** | 104 | .02* | 111 | .33 |

Note: * a low r-value may reflect a low standard deviation

### 4.4 Detailed Analysis of Intentions

Table 6 provides a cross tabulation of intention to use gene technology 2000 and 2002 to show in more detail how farmer and grower intentions had changed. The table shows 49 respondents (45 per cent), the sum of the diagonal cells identified in the table by a gray background, had not changed their response from 2000 to 2002. Twenty-five (23 per cent) had become less positive or more averse to using gene technology, whereas 34 (31 per cent) had become more positive or less averse. These changes occurred mostly within intentions to use and intentions not to use gene technology. Nevertheless, two farmers and growers had moved from having a positive to a negative intention and five made a change from negative to positive intentions. In addition, while those with positive intentions had increased from 24 in

2000 to 28 in 2002, 25 per cent of those holding these intentions in 2000 no longer intended to use the technology.

**Table 6**
**Intention to Use Gene Technology, 2000 and 2002**

| | | Intention 2000 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Very strong intention not to use | Strong intention not to use | Intention not to use | No intention | Intention to use | Strong intention to use | Very strong intention to use | Total 2002 |
| Intention 2002 | Very strong intention not to use | 12 | 4 | 4 | 2 | 1 | | 1 | 24 |
| | Strong intention not to use | 3 | | 1 | 2 | | | | 6 |
| | Intention not to use | 2 | 3 | 5 | 3 | 1 | | | 14 |
| | No intention | 4 | 4 | 4 | 21 | 3 | | | 36 |
| | Intention to use | | 1 | 4 | 3 | 9 | 1 | 2 | 20 |
| | Strong intention to use | | | | 2 | 1 | 2 | | 5 |
| | Very strong intention to use | | | | | 1 | 2 | | 3 |
| | Total 2000 | 21 | 12 | 18 | 33 | 16 | 5 | 3 | 108 |

## 4.5 Relationships Between Items

Given the limited degree of change in intentions over time it is interesting to investigate whether the belief-attitude-intention relations held under these conditions. In other words, the investigation is of whether farmers and growers who changed their intentions also requisitely changed their attitudes and beliefs.

The summation of respondent beliefs about gene technology for 2002 (mean 12.3, range –27 to 63, std. dev. 18.29, n = 108) like other measures was slightly more positive than the belief summation for 2000 (mean 2.7, range –46 to 72, std. dev. 20.46, n = 105). Differences between the summations were also significant (paired sample t-test, $p < 0.001$). There was evidence of internal consistency for the eight beliefs in 2000 (Cronbach's alpha = .70) and 2002 (Cronbach's alpha = .76).

From responses to the 2000 study, evidence of relationships were found between the sum of beliefs and attitude ($r = 0.56$, $P < 0.001$, $n = 103$), and attitude and intention to use gene technology ($r = 0.70$, $p < 0.001$, $n = 111$). From 2002 study, evidence of relationships were

found between; the sum of beliefs and attitude ($r = 0.64$, $p < 0.001$, $n = 102$), and attitude and intention to use gene technology ($r = 0.70$, $p < 0.001$, $n = 106$). These strong positive relations support the interpretation that consequences of the use of gene technology are important factors in decisions to use or not use the technology. Indeed, this interpretation is supported further with the finding that farmer and grower beliefs about these consequences have altered in correspondence with changes in intention. Given these results, farmer and grower decisions are likely to be strongly influenced by the economic, environmental, social and production implications of gene technology tested in this study.

Further investigation of the 2002 data showed intention to use gene technology corresponded with intention to purchase GM food ($r = 0.73$, $p < 0.001$, $n = 112$) and agreement with the imperative for New Zealand to become GE free ($r = -0.57$, $p < 0.001$, $n = 106$). In addition, inverse correspondence was found with intention to use organic methods ($r = -0.42$, $p < 0.001$, $n = 106$). In cross-tabulation, only one of the 115 respondents had a positive intention to use both organic methods and gene technology. This was fewer than in 2000 when ten of the respondents had a positive intention to do both. It appears that farmers and growers are treating the activities as incompatible, which means it is likely that an increase in intentions to use gene technology is dependant upon a reduction in intentions to use organic methods.

Like the relationship between attitudes and intentions to use gene technology, attitude to purchasing GM food and intention to purchase GM food were strongly correlated ($r = 0.75$, $p < 0.001$, $n = 105$). In addition, attitudes towards using organic methods correlated with intentions to use organic methods ($r = 0.45$, $p < 0.001$, $n = 105$).

### 4.6 Comparison with Independent Measures Taken in 2002

Several key questions from the 2000 survey were repeated in an independent 2002 survey conducted by the AERU (N = 805; Fairweather, Maslin, Gossman & Campbell, 2003). This study, with a broader aim than the 2000 study, took a fresh sample of New Zealand farmers and growers to investigate further farmer and grower views on genetic engineering, organic production methods and sustainability.

The independent 2002 study showed that intention to use GMOs (genetically modified organisms) was generally negative ($\bar{x}$ -0.15, sd 1.51, $n = 798$, range –3 to 3) although this was somewhat less negative than the 2000 measure of intention to use gene technology ($\bar{x}$ -0.29, sd 1.25, $n = 650$, range –3 to 3). The difference between the 2000 measure of intention to use gene technology and the independent 2002 measure of intention to use GMOs was significant (independent sample t-test, $p < 0.05$). Of note, the independent 2002 survey had measured ‘intention to use GMOs’ rather than ‘intention to use gene technology’. Given the range of terms and abbreviations commonly used to describe genetic engineering or its products (e.g., biotechnology, GM food) differences were assumed to be by label and are not assumed to entail differences in meaning.

In 2002, agreement with the imperative to become GE free was generally neutral ($\bar{x}$ 0.002, sd 1.81, $n = 786$, range –3 to 3) and was less negative than the same measure taken in 2000 ($\bar{x}$ -0.49, sd 1.81, $n = 644$, range –3 to 3). Of interest, in 2000, 50 per cent of farmers indicated disagreement with GE free status in New Zealand, while in the independent 2002 survey that proportion had decreased to 46 per cent.

The independent 2002 study also measured intentions to use organic methods. Positive intentions to use organic methods were found ($\bar{x}$ 0.15, sd 1.51, n = 798, range –3 to 3) but farmers and growers were less positive about using organic production methods in 2002 than they were in 2000 ($\bar{x}$ 0.29, sd 1.25, n = 650, range –3 to 3).

In summary, the comparison between items measured in the 2000 survey and again in the 2002 independent survey was interpreted as showing significant (independent sample t-tests) differences. The re-survey results of 115 of the original respondents to the 2000 survey are aligned to, but not entirely accordant with, these findings. With the exception of agreement with the need to be GE free, consonant shifts of the same direction were recorded, however, unlike the independent 2002 results, these were of insufficient magnitude to warrant claims that a meaningful change had occurred.

# Chapter 5
# Discussion and Conclusion

It is important, first, to qualify the results in terms of the validity of claims that can be made about farmers and growers in general. With reference to the re-survey, tests for representativeness found no evidence of significant response bias and comparison between the re-survey sample and the population of farmers and growers found no evidence of significant differences. Nevertheless, because of the small number of respondents (n = 115), minor differences between results form this sample and results from other samples of the population can be expected.

With respect to the independent 2002 study, it also was representative of the population of farmers and growers and because of the larger sample size can be regarded as a more accurate representation of farmer and grower views in 2002 than the smaller 2002 re-survey. Nevertheless, despite its smaller sample size, the re-survey was specifically designed to track changes in farmer and grower views, whereas this was only one of a number of objectives of the independent 2002 study. For the purpose of examining changes in farmer and grower views the 2002 re-survey results are superior and the following discussion gives emphasis to these results. The independent 2002 results are discussed as they relate to these results.

With reference to the results of the re-survey, in terms of the aim of examining changes in farmer and grower decisions, because of non-significant results for attitudes and intentions farmers and growers appear to be no more accepting of gene technology than they were two years ago.

Closer inspection of consistency between responses over time showed that the 115 farmer and growers had changed their views by a moderate degree since 2000. Examination of the results showed that slightly more farmers and growers intended to use gene technology (25 per cent) than two years ago (22 per cent), though these farmers and growers remained a minority with 41 per cent having a negative intention and 34 per cent being undecided. Attitudes towards using gene technology appear to be slightly more favourable and assessments of consequences of using the technology were also, in general, slightly more positive.

Changes in intentions and attitudes were insufficient to warrant a claim that a meaningful shift in opinion had occurred. The results, nevertheless, also showed that a change in thinking about some aspects of using gene technology had occurred. The results indicate that farmers and growers had changed their minds about New Zealand becoming GE free. Significantly fewer farmers and growers than two years ago agreed that New Zealand should become ‘GE free’. In addition, while there is still a good deal of concern over risks from using gene technology, it was thought less likely that using gene technology would damage ecological systems or result in new risks to public health. Also, the positive outcomes of enhanced economic growth and increased food production were considered more likely than two years ago.

In measures of other attitudes and intentions, minor moderation in aversion to GM food was evident, as well as a minor decrease in intentions to use organic methods. Like intentions to use gene technology, these changes were non-significant and cannot be interpreted as indicating that a meaningful change had been found in this study.

Comparison of results from the independent 2002 survey with results from the 2000 survey, on face value, indicated a larger shift in preferences had occurred than the re-survey had indicated. This shift in thinking, indicated by the independent study, suggests a minor positive shift in preferences towards the use of gene technology and against the use of organic methods. Indeed, despite showing a significant difference, the detailed analysis undertaken by Fairweather, Maslin, Gossman & Campbell, (2003) showed that, in comparison to 2000, there was a decrease in negative intentions and an increase in neutral responses. Importantly, however, there was no increase in the proportion of farmers and growers who had positive intentions to use gene technology.

In terms of explaining farmer and grower intentions, the re-survey found strong relationships between the sum of beliefs, attitudes and intentions to use gene technology. Attitude-behaviour modelling in Social Psychology interprets these relationships as showing that changes in attitude and intention are the result of changes in beliefs about the consequences of performing an intended action (Ajzen and Fishbein, 1980; Ajzen 1991). In keeping with this interpretation, a positive or negative change in any of the beliefs assessed by farmers and growers will effect a corresponding change in attitude and a corresponding change in intention. A more positive attitude will arise through farmers and growers determining that harmful consequences are less likely. Attitude would also improve with evidence that the perceived benefits of better quality food, economic growth and increased food production would be realised. Farmers and growers deciding that risk to public health or personal health, damage to ecological systems and adverse effects on future generations were unlikely, would also result in more favourable attitudes and intentions. Indeed, the beliefs of farmer and growers are readily encapsulated as conditional factors in terms market acceptance, commercial viability and environmental risk. In other words, farmers and growers who intend to use gene technology appear to be speculating that applications of the technology that are economically viable and marketable with regulatory approval will be available in the next ten years.

Finding that the belief-attitude-intention relationship holds despite some variation between 2000 and 2002 gives further emphasis to the importance of beliefs in farmer and grower decisions. The variation is itself a matter of interest. Approximately half of the respondents had changed their intention in some way since 2000. To assess whether this is significant, attitude-behaviour studies provide a useful benchmark through studies of the relationship between intention and actual behaviour. The intention-behaviour relationship is different from the intention-intention relationship measured in this report because, for example, despite favourable intentions actual behaviour may present unforeseen factors that can impact upon behavioural performance. In consequence, intention–intention measures should be more correspondent than intention-behaviour measures. Three meta-analytic reviews provide details of intention-behaviour correspondence. Sheppard, Hartwick and Warshaw (1988) found a mean r-value of 0.53 from 87 studies, Randall and Wolff (1994) found a mean r-value of 0.45 from 98 studies and most recently Armitage and Conner (2001) report a mean r-value of 0.47 from 48 studies. Of particular relevance, Randall and Wolff (1994) reported a mean r-value of 0.40 for 14 studies with a time period of one or more years between measurement of intention and actual behaviour. In comparison, the r-value of 0.59 for a change in farmers and growers intentions may not be exceptional. Indeed, in the context of there being no approved applications of gene technology, uncertainty regarding consumer acceptance and no evidence of commercial viability under New Zealand conditions, this degree of variability should be expected.

To consider the results in broader context, for those farmers and growers considering using gene technology it would appear to be a practical rationalisation based upon practical concerns. For these farmers and growers, it must first be shown that there are acceptable levels of risk. In this way farmer and grower concerns about damage to ecological systems, adverse effects on future generations, personal risk and risks to public health could be satisfactorily addressed. Second, the marketplace must be accepting of use of the technology in agricultural production, which for these farmers and growers would satisfy their concern about consumer acceptance. Third, financial rewards from either efficiency in production or better returns for produce must be evident. As this study indicated, evidence of increased food production, better quality food as well as enhanced economic growth for New Zealand would be particularly encouraging for farmers and growers. However, while the acceptance of gene technology appears reasonably straightforward, preferences for organic methods present a difficulty. Organic methods and gene technology are perceived as incompatible. This means that, based on the results of this re-survey, approximately 38 per cent of farmers and growers believe they cannot seriously consider using gene technology.

The re-survey has indicated that, while there is some indication of lowered aversion to using gene technology, little has changed since the initial survey two years ago. A minor proportion of farmers and growers appear to be set to use gene technology to enhance productivity. As yet, however, this tool is not at hand and, as this study suggests, there is presently no reason for farmers and growers to become more, or less, accepting of the technology. Farmer and grower decisions are, nevertheless, dynamic and their beliefs and preferences represent key factors that will ultimately influence their actions. In this way, while farmers and growers may welcome any development that holds the prospect of improving their business, their intentions are, nevertheless, dependant upon the realisation of relevant benefits and evidence of acceptable risk from the use of genetic engineering in agriculture.

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